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NEWS

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Energy-Efficient Direct-Current Powering

participated.

Figure 1. Flywheel uninterruptible power supply (UPS)

Eliminating power conversion losses by using direct current (DC) instead of alternating current (AC) from the electricity grid to power data centers can trim energy use by an estimated 10 to 20 percent. Preliminary measurements from the Newark demonstration center are consistent with this estimate. Figure 1 through 5 show a selection of technologies that were on view.

The Berkeley Lab team of William Tschudi and Evan Mills, conceived the project and oversaw the demonstration's planning and design, which is being executed by private-sector firms ECOS Consulting and EPRI Solutions under a contract with Berkeley Lab. The partner companies provided technical advice, equipment, and staff to set up the demonstration at Sun Microsystems' Newark, CA facility, which was open to interested parties from June through August. The California Energy Commission's Public Interest Energy Research (PIER) program sponsored the project.

Growing Energy Use in Data Centers

Data centers are the backbone of the internet, providing data storage for websites and databases accessible over the World Wide Web and supporting virtually every large private corporation and institution.

Data center managers say that the rapid growth in their power and cooling requirements as well as electricity costs have become significant concerns.

Data centers typically operate 24 hours a day, seven days a week. According to a recent report published by Berkeley Lab ("High-Tech Means High Efficiency"), SEMATECH and other industry-leading data centers have among the highest density of energy-consuming equipment of any modern building.

"They can use 100 times the electricity of a typical office building on a square-foot basis," says Tschudi, EETD's principal investigator for this project. "Energy costs of $1 million per month are not uncommon in large data centers that require megawatts of electricity."

Factors such as the rapid growth of the web, the increase in use of networks to help geographically dispersed teams, and increases in server power have led to rapid growth in data centers and their energy use. Facilities managers, corporate information services departments, and internet service providers are searching for ways to reduce energy costs.

"We're excited to be able to demonstrate and evaluate the efficiency merits of two different data center DC-power-delivery approaches and expect our results can inform data center

operators, facility designers, and this global industry regarding efficient options for future designs," says My Ton of ECOS Consulting.

Figure 2. Servers modified to accept 380V DC

DC Power Increases Efficiency and Enhances Reliability

A number of strategies are increasingly being used by data center facilities managers to decrease their electricity consumption. These include optimizing airflows to get the most out of cooling systems, upgrading the energy efficiency of cooling systems, or shifting to liquid cooling.

Using DC power is a complementary strategy for improving energy efficiency. In a typical data center, the redundant power distribution system provides 480-volt AC power through an uninterruptable power supply (UPS) and then to a transformer, which then steps it down to 208-volt AC at a power distribution unit (PDU) to feed racks of servers. Within the UPS system, the 480 volt AC is converted to DC and charges batteries and then is converted back to 480 volt DC.

Individual power supplies (typically redundant) within each server convert the 208-volt AC into a voltage appropriate for the unit's needs. These individual supplies are often inefficient, generating substantial heat that the room's air conditioning system must remove at great expense. This heat can also limit the number of servers that can be housed in a data center and can jeopardize data center reliability if not handled properly.

Figure 3. AC and DC distribution systems in side-by-side comparison

Some servers on the market operate on DC power, typically 48 volts DC, which is the standard in the telecommunications industry. The Newark, CA demonstration shows that a DC-powered data center can skip the conversion from DC power directly to the servers. The DC demonstration system converts high-voltage AC directly into high-voltage DC power; the high-voltage DC is stepped down to low voltage within the information technology equipment. By skipping conversion steps, this approach can save 20 percent or more of overall electricity use.

However, the idea of substituting DC power for conventional AC power has not yet made significant inroads into many data centers because the technology is unfamiliar to many facilities engineers and standardization of distribution voltage and DC connectors would be needed. The industry is reluctant to switch to new technologies without field experience showing that the switch can be done safely and produce operational and economic benefits.

Figure 4. DC connectors need to be standardized similar to AC connectors.

The Applications Team Steps In

The Applications Team (A-Team) is an EETD group that tackles demonstration projects involving advanced, energy-efficient technologies that are not yet mainstream in the marketplace. The group targets technologies that have great energy-efficiency potential and other advantages (e.g., improved comfort or safety, lower maintenance and operating costs) but need field testing or demonstration under real conditions to prove the benefits to users. DC-powered data centers were an ideal project for the A-Team.

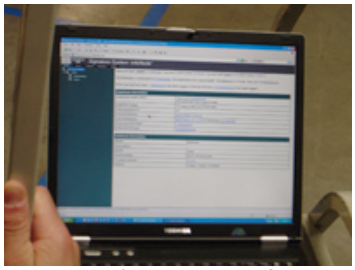

Figure 5. On-line monitoring of energy performance.

"This project is meant to show that energy savings are possible by minimizing energy conversions within the data center and its equipment. Many well known companies have been involved, including vendors who are eager to sell DC technology solutions to the marketplace," says Tschudi.

All of the demonstration DC equipment was loaned by the manufacturers. This project is actually two demonstrations: one shows off DC architecture at a facility level, distributing 380

The industry participants and the California Energy Commission have formed a stakeholder group that evaluated the results of the demonstration, provided a summary of energy savings, and compared the performances of DC-powered and conventional data centers. This group is working to standardize distribution voltages and DC connectors to enable the technology to become adopted.

—Allan Chen

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